



Providing science to inform restoration considering climate change for the San Francisco Bay-Delta estuary

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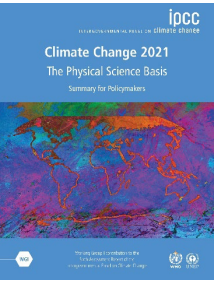
Western Ecological Research Center

National Conference on Ecosystem Restoration (NCER)

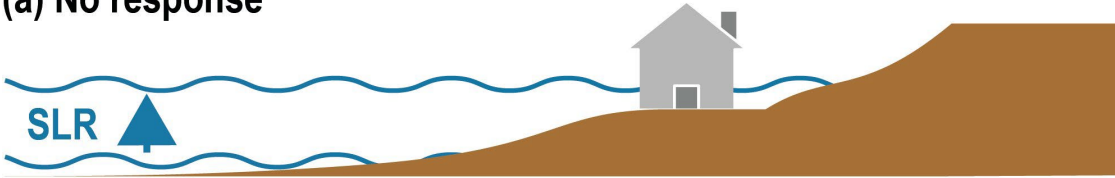
April 14-19, 2024; Albuquerque, NM

Session “Restoring the Sacramento-San Joaquin Delta and San Francisco Bay: Past, Present, and Future”

Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years



(a) No response



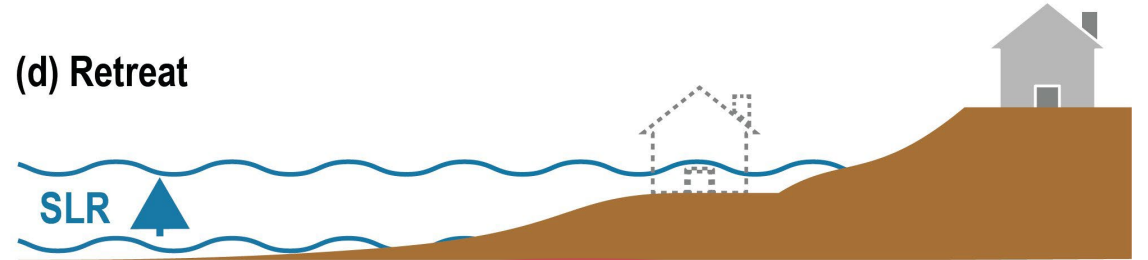
(b) Advance



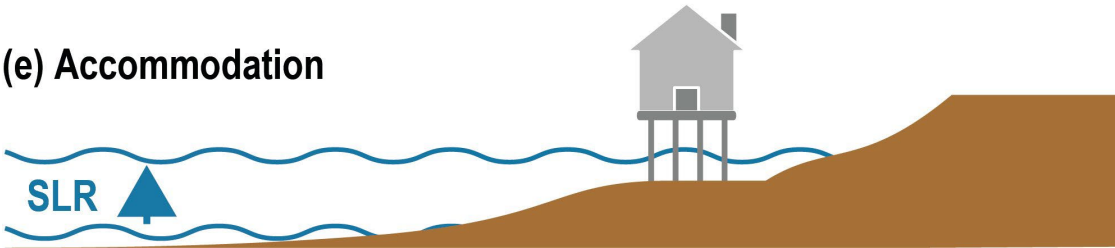
(c) Protection



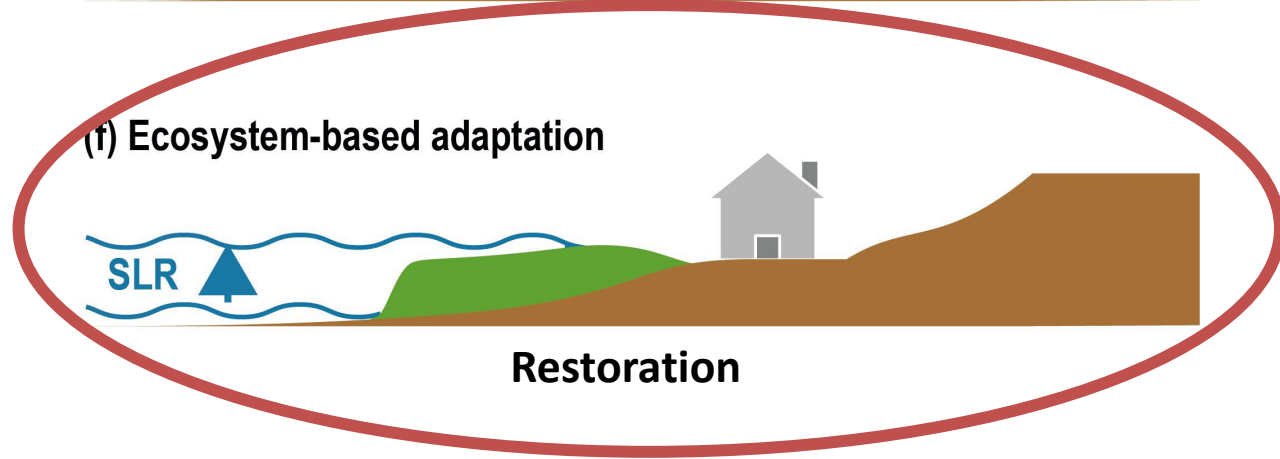
(d) Retreat



(e) Accommodation

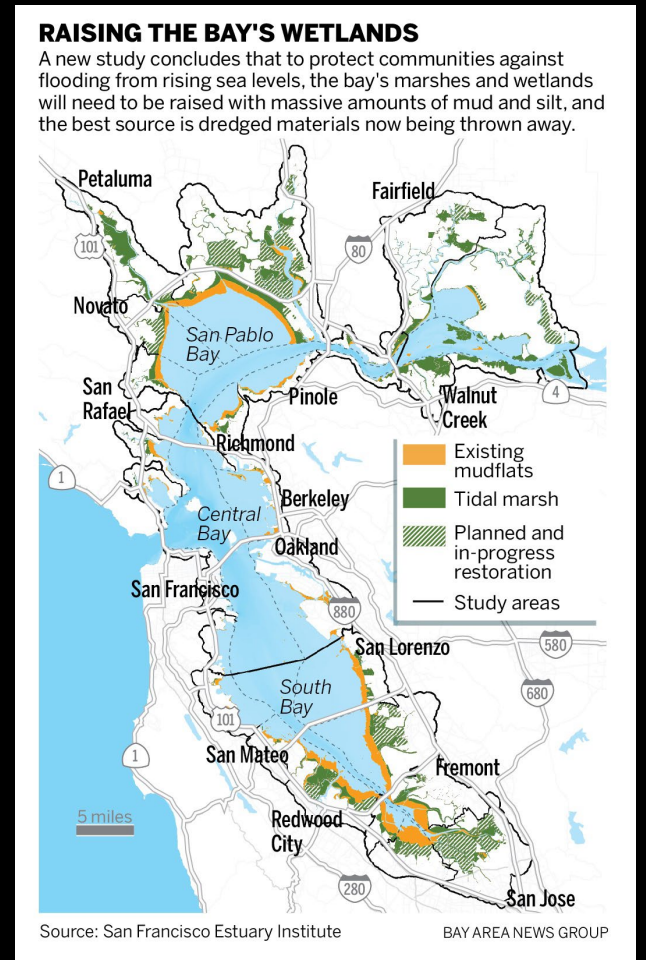


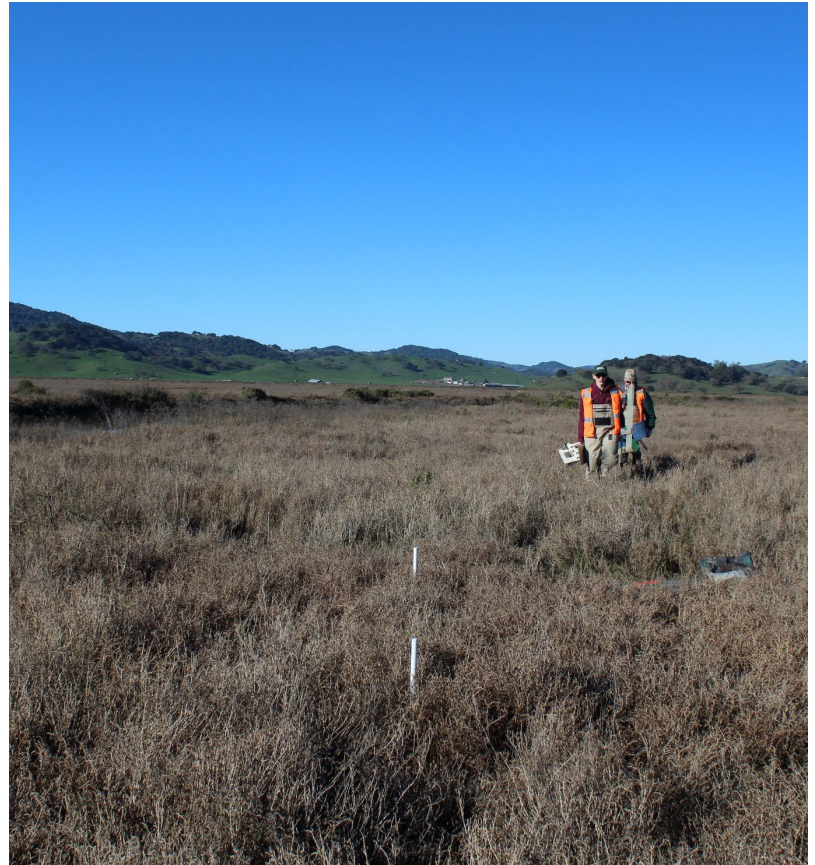
(f) Ecosystem-based adaptation



San Francisco Bay-Delta wetland restoration

- Loss of 70-90% of wetlands across the region
- Tidal & salinity gradient, mosaic of fresh, brackish, and saline wetlands
- Common goal: restore wetlands for
 - Fish and wildlife habitat
 - Improved water quality
 - Flood protection
 - Carbon sequestration
 - Recreation
- Actively restoring wetlands for over 50 years



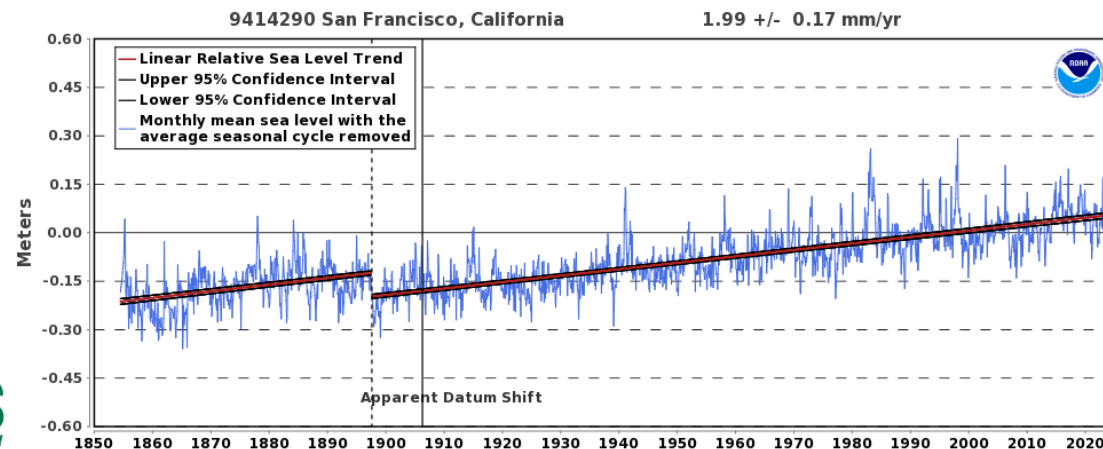
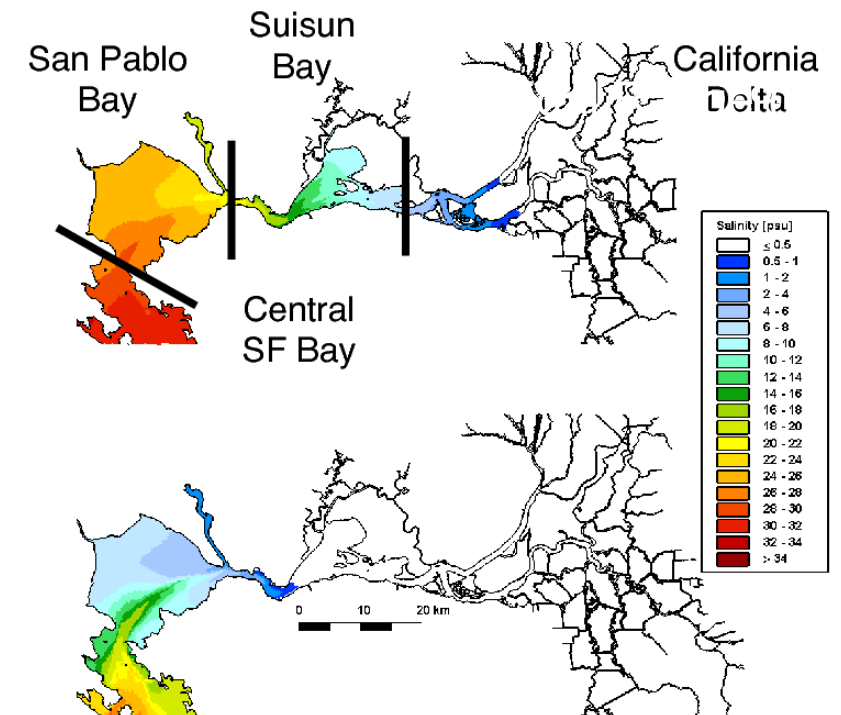


Wetlands of San Francisco Bay-Delta



San Francisco Bay-Delta has complicated physical processes influencing wetlands and restoration

- Mixed-semi diurnal tides
- Different embayment physical processes
- Sea-level rise
- Salinity gradient
- Variable freshwater flows



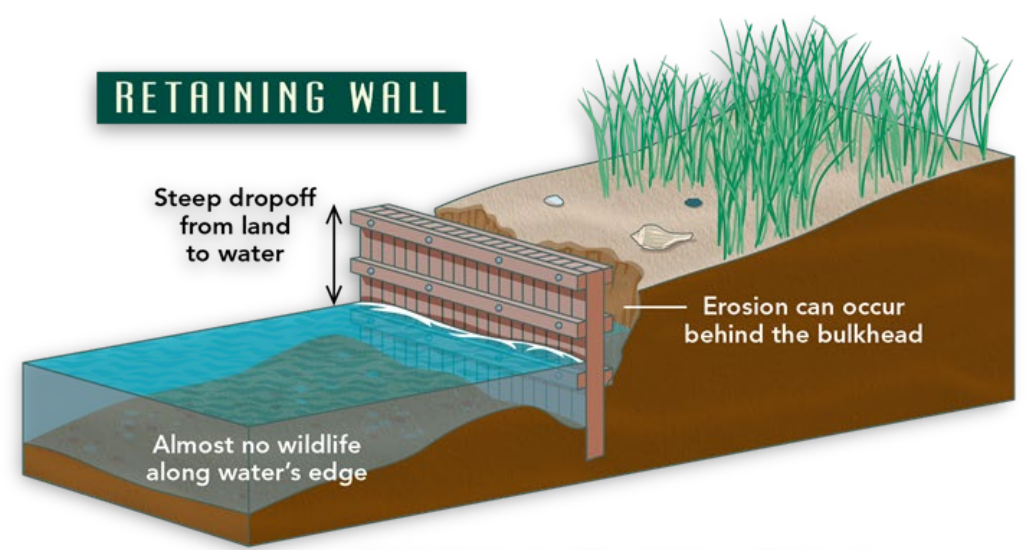
Kimmerer et al. 2013

Wetland restoration within an uncertain future

Wetland restoration is an essential strategy for addressing climate change

- Carbon sequestration to offset greenhouse gases
- Buffering communities from storm surges, reduced wave damage and floods, stabilizes shorelines

Management question: How do we design and implement wetland restorations given climate change and sea-level rise?



'Hard' infrastructure like retaining walls abruptly severs the ecological connection between the coast and water.



Not only do Living Shorelines defend land against destructive waves, but they also provide crucial habitat for fish and wildlife.

From: Delaware Living Shoreline Committee

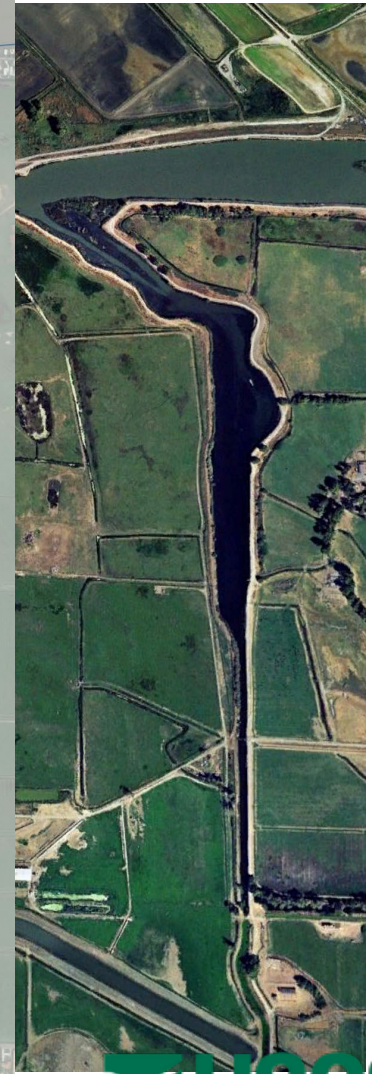
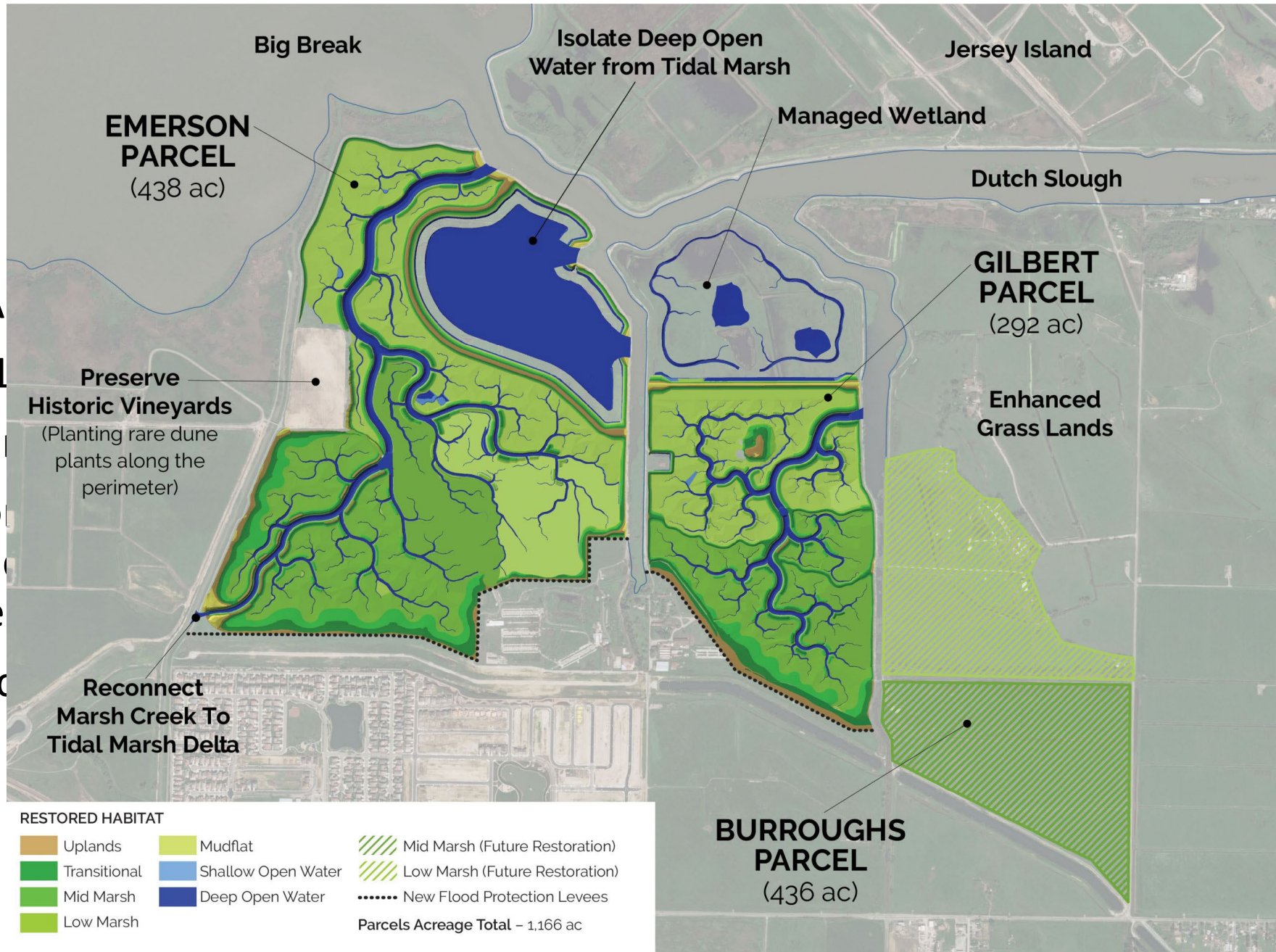
Key wetland restoration research questions?

Are restorations gaining elevations and outpacing sea-level rise?

Have wetland restorations achieved their planned goals?

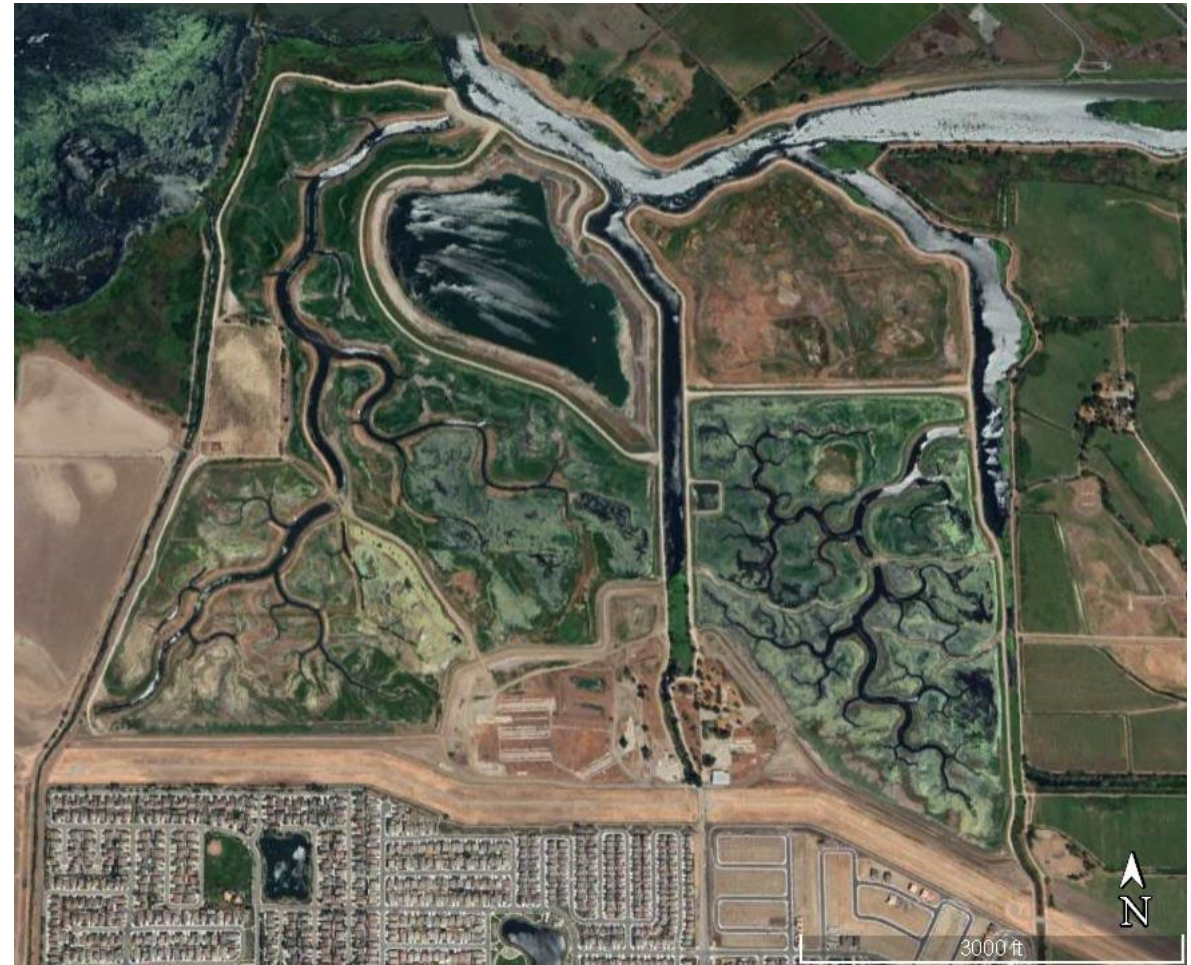
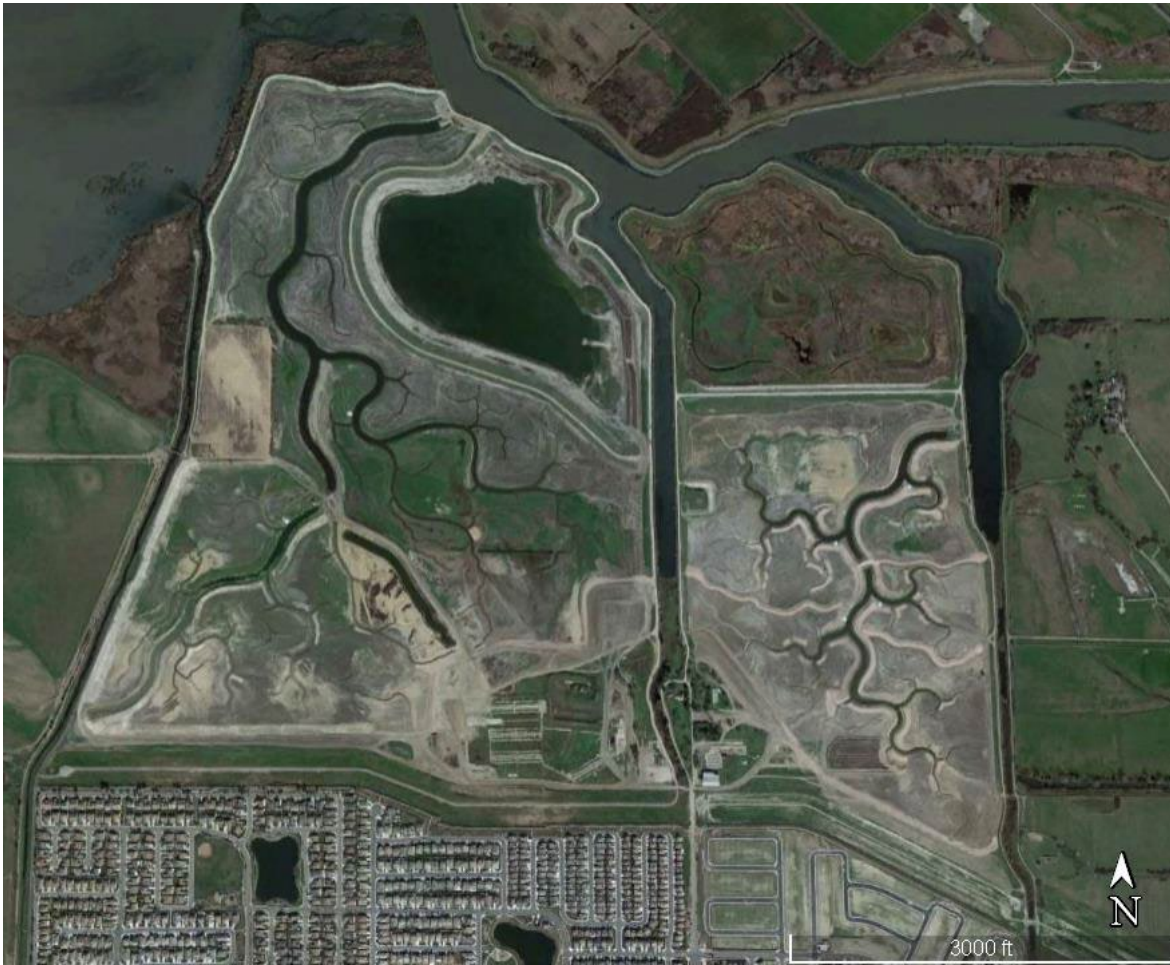
Are restorations removing greenhouse gases?

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Are wetland restorations removing greenhouse gases?

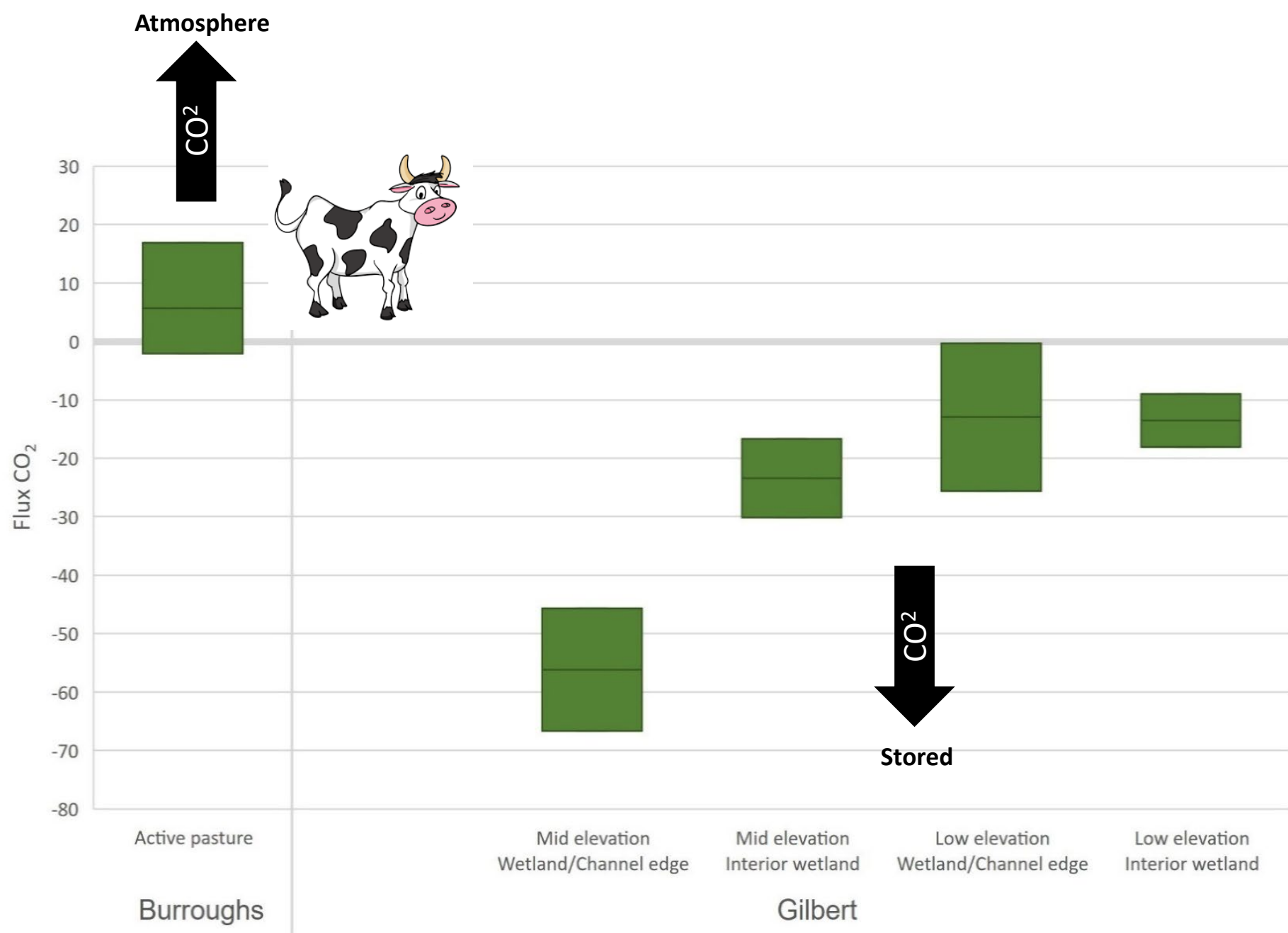
Dutch Slough Wetland Restoration



Are wetland restorations removing greenhouse gases?

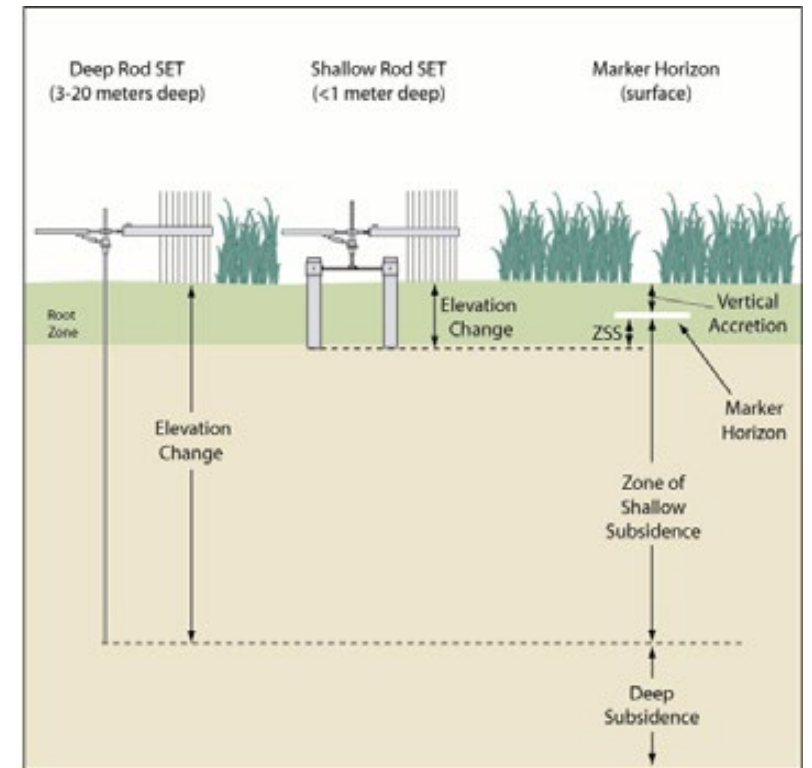
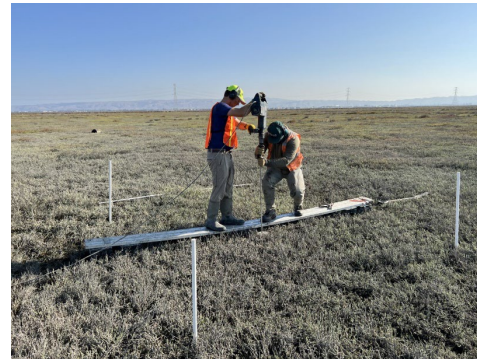
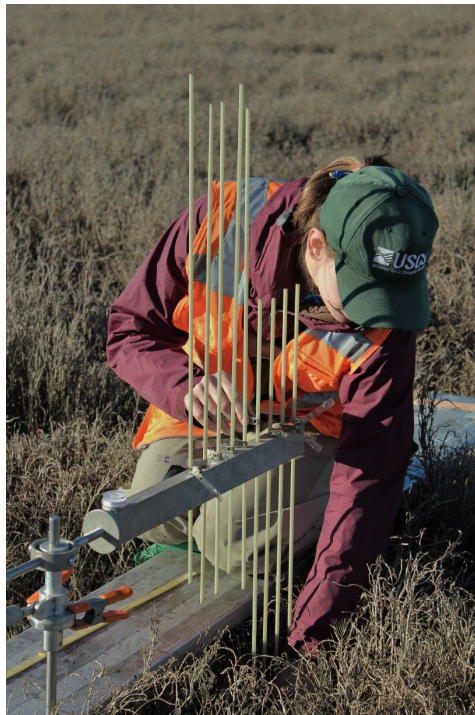
- Greenhouse gas fluxes measured pre- and post- breach AND seasonally (winter/summer)
- Soil cores collected at restoration and local reference sites to assess carbon stock potential of restoration



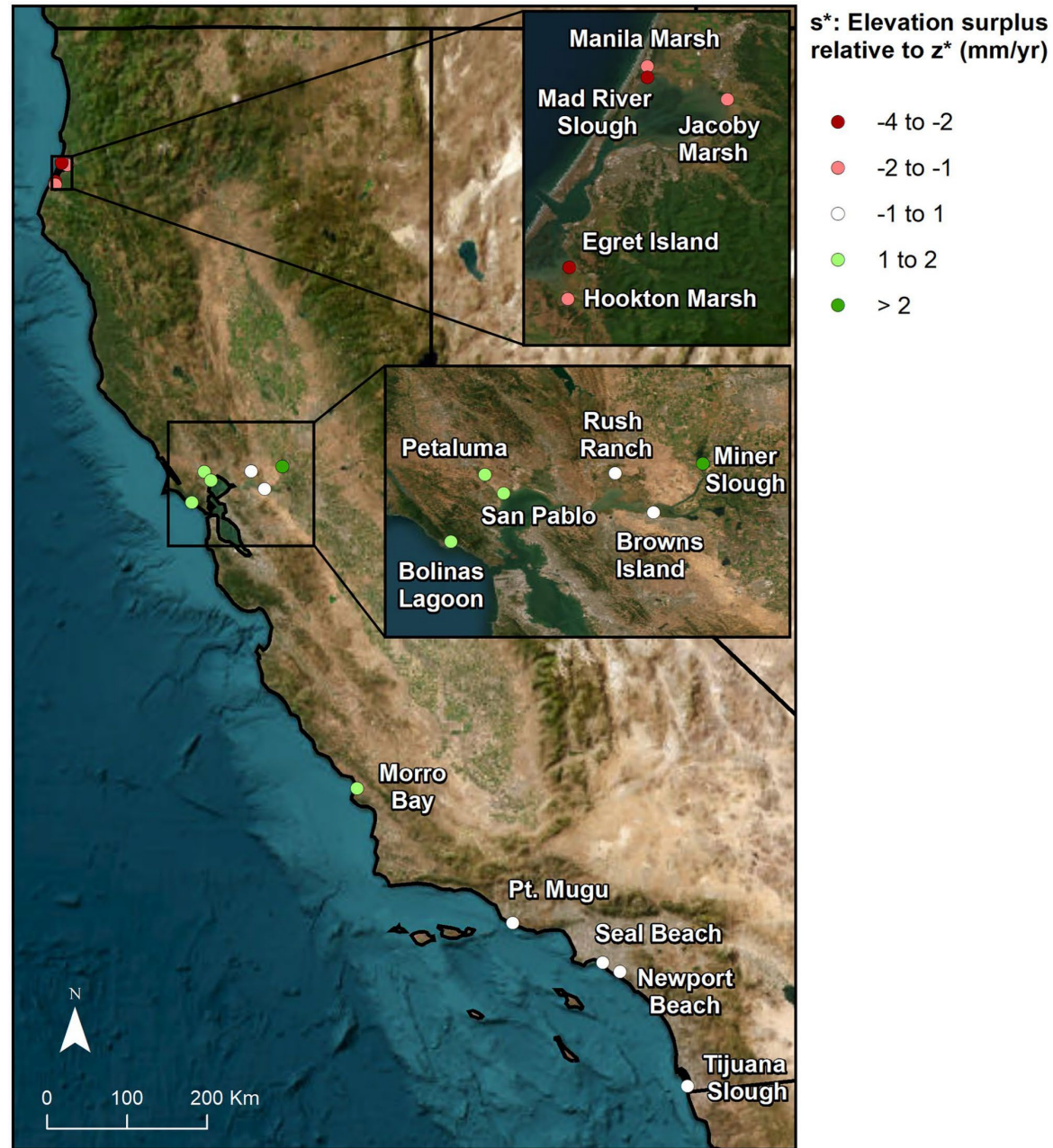


Are wetland restorations gaining elevations and outpacing sea-level rise?

Surface elevation tables and marker horizons

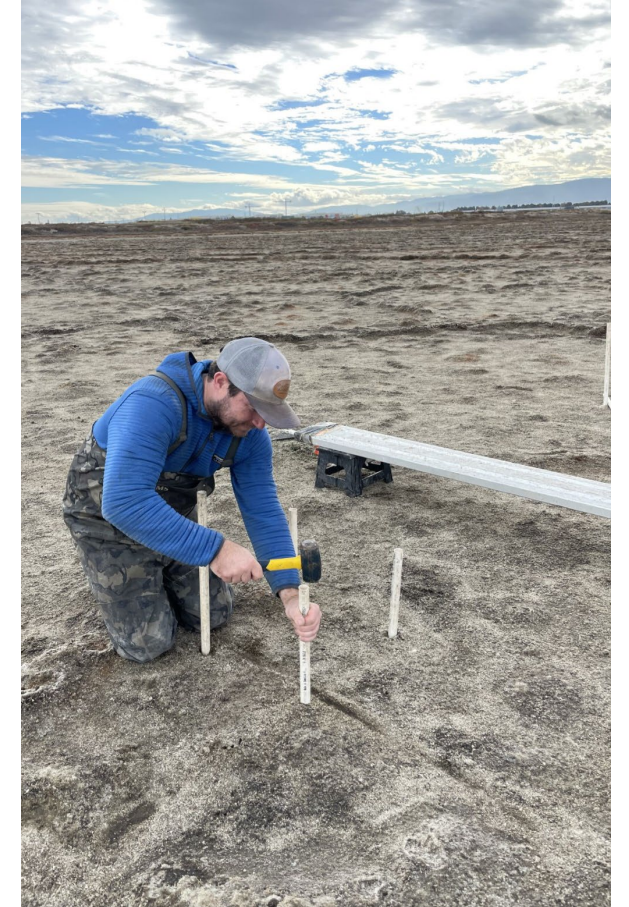
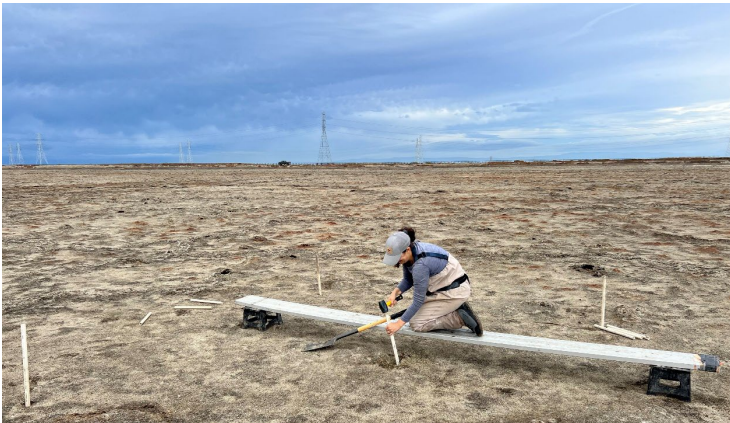


Soil profile measured by Surface Elevation Table and marker horizon techniques.(Cahoon and Lynch, 2002)



Are wetland restorations gaining elevations and outpacing sea-level rise?

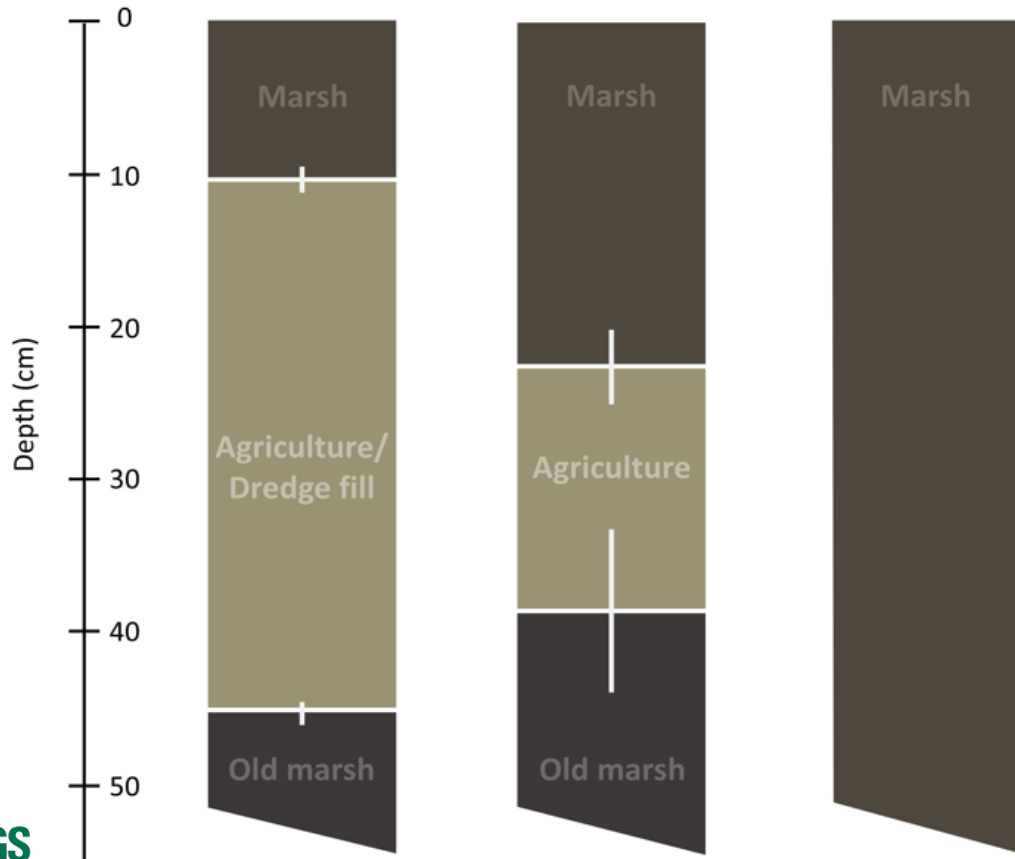
- Dotson Marsh
 - Fill, scraped down to marsh elevation in 2017
 - **8 SETs** installed 2023
- Ravenswood Pond
 - Restoring historic salt pond
 - **4 SETs** installed 2023



R4 restoring salt pond, pre-breach Dec 2023

Have wetland restorations achieved their planned goals?

	Beneficial reuse Sonoma Baylands (1996)	Natural accretion Tolay Creek (1997)	Old tidal wetland Centennial Strip Marsh
Marsh accretion:	0.38 ± 0.06 cm/yr	0.84 ± 0.18 cm/yr	0.44 ± 0.16 cm/yr





Conclusion

- We can no longer plan for a static future
- Incorporating sea-level rise and climate change into restoration planning and implementation early is key
- Near term benefits of restoration are important even if there is long-term loss



Acknowledgment

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